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for

PORTABLE WATER HEATER

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PORTABLE WATER HEATER

CROSS-REFERENCE TO RELATED APPLICATIONS

[001] This application is a continuation-in-part application of U.S. Patent Application No. 10/216,496, filed August 9, 2002, which claims the benefit of U.S. Provisional Patent Application No. 60/311,731, filed August 10, 2001 and entitled "Portable Water Heater," both of which applications are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[002] The present invention generally relates to a portable water heater and, in particular, to a portable hot shower for use while camping, boating, hunting, hiking, fishing, backpacking, emergency use, hazardous materials situations, industrial use, etc.

2. Description of Related Art

[003] Various types of devices have been used for many centuries for heating water, but water heaters that are truly portable and easy to use are not readily available. For example, campers and other outdoor enthusiasts requiring hot water often use a fire or cook stove to heat a container of water. The time required to heat even a small amount of water is significant, for example, up to fifteen or twenty minutes to heat a gallon of water.

[004] Portable showers and hot water heaters that can be used in a variety of situations and locations are also known and have been used for many years, but these conventional portable showers often do not provide adequate hot water. For example,

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in an attempt to keep such showers small and portable, relatively small heat sources have been used. Unfortunately, these small heat sources are usually not powerful enough to provide the desired supply of hot water. Gas powered devices, which provide a larger heat source, have traditionally not been used because of their size and bulk.

[005] Additionally, conventional portable showers often used gravity to deliver the water to the individual taking a shower. The force of gravity, however, often does not provide adequate water pressure or sufficient force to deliver the water as a fine spray. In addition, gravity powered showers require the user to find a location above the head of the user to place a large reservoir of water, which typically contains about two gallons of water and weighs about twenty pounds. It is often difficult to find a sturdy location to place the reservoir of water, especially when camping in remote or desert locations. It can also be difficult and dangerous to lift the relatively heavy reservoir of water into the desired location. Conventional portable showers have also used pumps to increase water pressure, but these pumps often required a large power source that is heavy and awkward to carry over long distances.

[006] Known portable showers often utilize a large container for holding the water. Typically, the water is heated within the container and a pump or gravity is used to supply the heated water from the container to the user. A significant drawback of these known portable showers is that the size of the container limits the amount of hot water available to the user. Thus, if more than one person wants to take a shower, each person must refill the container with cold water, and that water must be heated before that person can take a hot shower. Heating the reservoir of water often takes a significant amount of time, especially if a small heat source is being used. Additionally, these conventional portable showers heat all the water in the container at the same time,

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requiring a substantial amount of heat from the heat source and a large amount of time to heat all the water in the container. Thus, depending upon the size of the heat source and container, it can take up to thirty minutes or more to heat the water in the container for a hot shower. Disadvantageously, the heated water in the container, which is generally poorly insulated or not insulated at all, constantly loses heat, thereby prolonging the time required to heat the water for a hot shower.

[007] Conventional portable showers are often not truly portable because they are heavy, awkward to carry, and include a plurality of parts that must be carefully assembled. In addition, conventional portable showers often require the user to assemble and erect a number of components before the shower can be used. Further, many of these known portable showers are expensive and require complex machinery to heat the water.

[008] It is also known to use solar power for portable showers, but solar heated water is dependent on direct sunlight for heat. Thus, if direct sunlight is not available, for instance on a cloudy day, a hot shower is not available. Further, solar heated systems require sunlight for a large portion of the day in order to sufficiently heat the water. Disadvantageously, this often requires the user to stay in one location for an extended period of time while the water is being heated. Another drawback of solar heated systems is the water container is not typically insulated, which allows a large amount of heat loss through the container. Further, solar heated systems do not work efficiently in low ambient temperature environments.

[009] Finally, it is desirous to have a portable shower that can be used in larger scale applications while still remaining portable. Such situations may involve hazardous materials in which a larger portable water heater is desirable to provide a

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high-strength stream of water to shower down multiple personnel as one of the required sanitation steps or as an emergency precaution. Other situations include industrial use in which a larger portable water heater may be desired for emergency or other applications. However such portable water heaters are not readily available or are cumbersome. Therefore, it would be an advantage to provide a larger-scale water heater that can handle these large-scale applications.

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BRIEF SUMMARY OF THE INVENTION

[010] A need therefore exists for a portable water heater that is truly convenient to use and eliminates the above-described problems.

[011] One aspect of the present invention is a portable water heater that allows the pleasure of hot showers to be taken at almost anytime and in almost any location. The portable hot shower can be used by a wide variety of people such as campers, outfitters, backpackers, horseback riders, hunters, rafters, bikers, mountain climbers and the like. The portable hot shower can also be used in many different locations such as in parks, cabins, recreational vehicles (RV's), boats, beaches, etc. Thus, the portable water heater can be used to provide hot showers virtually anywhere in the outdoors, in cabins without electrical power or water heaters, or wherever a hot shower is desired.

[012] Another aspect of the portable water heater is it provides heated water very quickly and efficiently. For example, the portable water heater does not have to heat an entire reservoir or container of water before supplying hot water. In contrast, the portable heater heats the water as it flows to the user without being stored or held in a container or reservoir either while the water is heated or thereafter. Thus, the water has minimal heat loss between the time the water is heated and its use by the user.

[013] In greater detail, in one embodiment, the portable water heater includes an intake that allows liquids or fluids, such as water, to enter the device. A pump is desirably located on the intake side of the heater to draw water into the device and through a conduit to a heating assembly. The heating assembly includes a heat transfer conduit that allows the water to pass through the assembly and a heat source that heats the water as it flows through the heat transfer conduit. The heat transfer conduit may include an upwardly spiraled or horizontally coiled tube that allows heat from the heat

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source to rapidly and efficiently heat the water flowing through the tubing. The heat source includes a fuel burner assembly, such as a gas-powered burner, that is located near the heat transfer conduit to heat the water as it flows through the tubing in the assembly. The heated water exits the heating assembly through an exit and enters an outlet tube or conduit that directs the water to the showerhead or other suitable type of fixture. This embodiment may be useful for smaller application such as personal showers. However, this embodiment may also be adapted for larger-scale applications.

[014] In yet another embodiment, a water heater is provided having a heating assembly which includes an outer housing. Outer housing 303 has a top wall, bottom wall, two sidewalls, a top cover, and a bottom cover. The heating assembly includes a heat transfer conduit and a fuel burner assembly disposed therein. The heat transfer conduit can be formed from a cylindrical coiled tubing and disposed about a horizontal axis. A plurality of plates may be disposed in the housing to support components of the fuel burner assembly and heat transfer conduit. In addition, the plates help contain the heat from the fuel burner assembly within the housing and help keep the sides of the housing from becoming too hot. The fuel burner assembly may include one or two burners disposed underneath the length of heat transfer conduit. The burners may be placed outside of the coiled tubing. This embodiment may be useful for large scale applications such as hazardous materials or emergency industrial use. However, it may also be adapted for smaller applications such as personal showering.

[015] In each embodiment, the portable water heater preferably uses a high-efficiency heat source such as a propane-powered burner. A propane-powered burner can provide up to 10,000 BTUs, or more, to quickly and efficiently heat the water. Additionally, the coiled tubing of the heat transfer conduit is preferably arranged to

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maximize the surface area of the tubing that is exposed to the heat source. Maximizing this surface area allows a maximum amount of heat to be transferred to the water in a minimum amount of time and space. Further, the coiled tubing is preferably constructed from a material, such as copper, that facilitates the transfer of heat from the heat source to the water.

[016] The portable water heater can provide a hot shower to a user in any location or setting, and it can be used in conjunction with a wide variety of water sources such as lakes, ponds, streams or rivers; culinary water supplies such as at houses, cabins or boats; or other external water sources. Significantly, the portable water heater can be used any time that hot water is desired, such as for showering, cooking and cleaning. Further, the portable water heater can be used in connection with other types of fluids or liquids that are desired to be heated quickly and efficiently.

[017] The portable water heater is a truly portable, light-weight and compact device that can be easily transported and assembled. Desirably, the portable water heater includes a carrying case in which all the components of the system can be easily stored when not in use. Advantageously, the carrying case can also be used to store and contain water for the water heater, if desired, when the water heater is being used. The carrying case preferably includes a recessed handle and a removable lid. The removable lid includes a recessed portion that can support all or a portion of the water heater in a desired position. In particular, the recessed portion is configured to receive a fuel source, such as a pressurized propane gas cylinder, for the water heater. Desirably, the recessed portion holds the fuel source and at least a portion of the portable water heater in an upright position. Thus, the lid of the carrying case can be used to provide a sturdy and stable base for the water heater. Alternatively, the portable water heater may

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be transported on a dolly or cart for larger-scale applications. However, even for these larger scale applications, the water heater is transported with great ease.

[018] Another aspect of the portable water heater is it allows any suitable quantity of water to be quickly and efficiently heated. For example, the portable water heater may provide enough hot water for a single shower or for a number of showers taken in rapid succession one after another. Advantageously, because the portable water heater does not heat a reservoir or large container of water, the water heater does not waste energy by heating water that is not used immediately. Additionally, the portable water heater is more efficient than conventional water heaters because it does not store or hold heated water in a reservoir until it is used. In contrast, the portable water heater heats the water as it flows to the user. Thus, minimal amounts of heat are lost before the hot water is used, and only a minimal amount of heated water is not used immediately after being heated. Therefore, the portable water heater is very efficient because it only heats the amount of water needed by the user at any given time, and the hot water is used immediately after it is heated.

[019] Yet another aspect of the portable water heater is it provides hot water within seconds of demand by the user. In particular, during operation the portable water heater draws water from the water source and heats it in the heating assembly. The water is then immediately used by the user. Thus, because the water is heated in the heating assembly as it flows to the user, the user does not have to wait for a reservoir or container of water to be heated.

[020] Still another aspect of the portable water heater is the water heater supplies hot water continuously as long as the fuel source supplies fuel to the fuel burner assembly, the water source provides water to the intake and power is supplied to the

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pump. Thus, the portable water heater can continually supply hot water when these conditions are satisfied.

[021] A further aspect of the portable water heater is the electrical power required by the pump can be provided by a variety of different sources. Preferably, a battery pack is used to provide electrical power to the pump. Advantageously, the battery pack can include rechargeable or replaceable batteries. Alternatively, electrical power can be supplied by any suitable external power source such as a car or recreational vehicle volt battery. Electrical power may also be supplied to the pump by a cigarette adaptor in a car or boat, or power from the cigarette adaptor may be used to recharge the battery.

[022] Yet another aspect of the portable water heater is it can be used in conjunction with other suitable devices such as a privacy enclosure. The privacy enclosure allows a person to use the portable water heater as a shower within a closed environment. The portable water heater can also be used with a collapsible or adjustable pole to create a hand washer or it can supply water to a sink for cooking or cleaning.

[023] The portable water heater is advantageously simple to assemble and disassemble. The water heater is also portable and lightweight because it has relatively few components and many of the components are constructed from lightweight materials such as plastic. The water heater is relatively easy to manufacture and assemble because it has relatively few parts, which significantly reduces manufacturing costs. The water heater is also rugged because it is constructed from durable materials and components that can withstand extended use in a wide variety of environments. Further, in contrast to conventional water heaters, the present water heater is truly

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portable and lightweight, allowing it to be readily used in a wide variety of situations and locations.

[024] Significantly, the portable water heater is easy to operate by simply placing the intake in a water source, igniting the heat source and powering the pump. The portable water heater is also relatively easy to repair because of its few parts and a readily understandable design.

[025] These and other aspects, features and advantages of the present invention will become more fully apparent from the following description of the preferred embodiments and appended claims.

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BRIEF DESCRIPTION OF THE DRAWINGS

[026] The appended drawings contain figures of preferred embodiments of the portable water heater, which illustrate some of the above-recited and other aspects, features and advantages of the present invention. It will be appreciated, however, that the illustrated drawings only illustrate preferred embodiments of the invention and are not to be considered limiting of its scope. The invention will be described and explained with additional specificity and detail through the following figures:

[027] Figure 1 illustrates a perspective view of one embodiment of the portable water heater, illustrating the portable water heater being used as a shower;

[028] Figure 2 is a partially exploded perspective view of the portable water heater shown in Figure 1;

[029] Figure 3 is a perspective view of a portion of the portable water heater shown in Figure 1, illustrating one embodiment of a fuel burner assembly;

[030] Figure 4 is a perspective view from the bottom and looking toward the top of a portion of the portable water heater shown in Figure 1, illustrating one embodiment of a heating assembly;

[031] Figure 5 is a side view of a portion of the portable water heater shown in Figure 1, illustrating a one embodiment of a heating assembly and one embodiment of a fuel burner assembly;

[032] Figure 6 is a partial cross sectional side view of the portion of the portable water heater shown in Figure 5;

[033] Figure 7 is a partial perspective view of another embodiment of a heating assembly;

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[034] Figure 8 is a partial cross sectional side view of a portion of the portable water heater shown in Figure 6, illustrating another possible embodiment of a heating assembly.

[035] Figure 9 is a perspective view of another embodiment of a portable water heater for use in larger scale applications;

[036] Figure 10 is a perspective view of the heating assembly of Figure 9, viewing the heating assembly from the top and illustrating the top cover attached;

[037] Figure 11 is a perspective view of the heating assembly of Figure 9, viewing the heating assembly from the bottom and illustrating the bottom cover attached;

[038] Figure 12 is a perspective view of the heating assembly of Figure 9, viewing the heating assembly from the top and illustrating the top cover removed;

[039] Figure 13 is a top plan view of the heating assembly of Figure 9, with the top cover removed;

[040] Figure 14 is a perspective view of the heating assembly of Figure 9, viewing the heating assembly from the bottom and illustrating the bottom cover removed;

[041] Figure 15 is a bottom plan view of the heating assembly of Figure 9, with the bottom cover removed; and

[042] Figure 16 is cross-sectional view of the heating assembly of Figure 9.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[043] The present invention involves a portable water heater that can be used to provide a hot shower in a variety of environments and locations. The principles of the present invention, however, are not limited to portable water heaters for hot showers. It will be understood that, in light of the present disclosure, the portable water heater can be successfully used in connection with other types of devices and uses, such as used for cooking and cleaning. Further, the water heater is also useful where larger quantities of water are needed, such as in, but not limited to, military, distaster or hazardous waste clean-up, fire, hospital, decontamination, and other similar settings. More broadly, the portable water heater can be used in almost any location to which a user is able to transport it, so that it is available for any reason that the user might need a running water supply.

[044] Additionally, to assist in the description of the portable water heater, words such as top, bottom, front, rear, right and left are used to describe the accompanying figures. It will be appreciated, however, that the portable water heater can be located in a variety of desired positions–including various angles, slopes and inclines. A detailed description of the portable water heater now follows.

[045] As seen in Figure 1, a portable water heater 10 can be used to provide a hot shower to a user in a variety of locations. For example, portable water heater 10 allows a user to take a hot shower while camping, hiking, climbing, backpacking, etc. The shower can be used in conjunction with a privacy enclosure 8, if so desired. Alternatively, portable water heater 10 can be used any time hot water is desired, such as for cooking and cleaning.

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[046] Figure 1 depicts one embodiment of portable water heater 10 which includes a power supply 30 and heating assembly 50. A pump 20 (not shown) is disposed in a water source 11. As seen in Figure 2, pump 20 includes an intake 12 that allows water or other suitable types of fluids from water source 11 to enter the device. Intake 12 desirably includes a removable cover 14 with a series of openings 16 to allow the water to enter pump 20. Intake 12 may also include a filter 18 that prevents foreign objects or other unwanted debris from entering the device. Advantageously, in one embodiment, cover 14 is threadably connected to intake 12 of pump 20 such that cover 14 can be removed and cleaned, and this also allows intake 12 to be directly connected to a water source such as a hose. It will be appreciated that cover 14 could also be attached using a snap fit or various other methods of retaining cover 14 on pump 20 which are known in the art.

[047] As shown in Figures 1 and 2, pump 20 is disposed in water source 11 to draw water into portable water heater 10. In one embodiment, pump 20 is encased in a durable material such as plastic to protect it from damage, and to allow pump 20 to be submerged in water. The design and configuration of intake 12 and pump 20 allow portable water heater 10 to be used in a wide variety of locations and environments because intake 12 and pump 20 can simply be inserted into any suitable water source 11, such as a lake, stream, pond or river. Advantageously, intake 12 and pump 20 can also be used in connection with other types of water sources 11, such as a culinary water supply, water container or reservoir.

[048] Pump 20 is preferably sized and configured to supply a sufficient volume of water for bathing or showering. One skilled in the art will appreciate that the volume of water delivered by pump 20 is dependent upon factors such as the size and speed of the

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pump. Thus, those skilled in the art will understand that the size and speed of pump 20, for example, may be varied depending upon the intended use of portable water heater 10. That is, pump 20 may be differently sized or configured if portable water heater 10 is intended to be used for showering or for cooking. Additionally, although in one embodiment pump 20 is depicted as being located near or formed in conjunction with intake 12, pump 20 could be located in any suitable location or portion of water heater 10 and still perform the function thereof with intake 12 being a separate member located remote from pump 20.

[049] Power supply 30 is electrically connected to pump 20 by an electrical line 32. As shown in Figure 2, power supply 30 includes a container 34 with a lid 36 and an on/off switch 38 for selectively controlling the flow of power to pump 20. In one embodiment, lid 36 is movingly attached to container 34. It will be appreciated that lid 36 could be attached to container 34 by hinges or by a resilient material that allows lid 36 to be selectively attached to container 34. Further, lid 36 and or container 34 of power supply 30 may include one or more inwardly extending bumps or protrusions that engage the lid 36. In another embodiment, lid 36 could be selectively attached to container 34 by a sliding arrangement formed on both lid 36 and container 34 such that when lid 36 is slidingly mounted on container 34 it cooperates therewith to removably lock in place. One skilled in the art will appreciate that various methods of moveably attaching or fasting lid 36 to container 34 may be utilized.

[050] Power supply 30 may include batteries. In one embodiment illustrated in Figure 2, power supply 30 uses multiple "D" sized batteries (not shown) that are inserted into container 34 to supply power to pump 30. More specifically, in one embodiment, power supply 30 includes four "D" sized batteries. It will be appreciated

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that depending on the size of power supply 30 and amount of water to be heated by portable water heater 10, various other numbers, sizes, and/or types of batteries may be utilized. The batteries used in power supply 30 may be replaceable or rechargeable, or power supply 30 may comprise a sealed battery. It will be appreciated that power provided by power supply 30 may vary according to the size and power requirements of pump 20. For example, a larger power supply 30 may be required for a larger pump 20 while a smaller power supply may be used with a smaller pump. Additionally, power may also be supplied by any suitable power source such as a car, recreational vehicle or boat battery, a cigarette lighter in a car or boat, connection to an electrical outlet or power grid, gasoline powered or other type of auxiliary motor, generator, or the like.

[051] As depicted in Figure 1, intake 12 and pump 20 are in fluid communication with an intake tube 40. In one embodiment, intake tube 40 is constructed from a resilient flexible material and allows the water to flow directly from pump 20 to a heating assembly 50. Advantageously, pump 20 provides pressurized water for the user and, when portable water heater 10 is being used in conjunction with a shower, the force of gravity is not required to cause the water to flow from water source 11 to a showerhead 134. In contrast, many conventional portable showers require the user to place a heavy reservoir of water above the individual using the shower and then use the force of gravity to cause the water to flow to showerhead 134.

[052] In one embodiment depicted in Figure 2, heating assembly 50 of portable heater 10 includes a housing 52. In this embodiment, housing 52 includes four sidewalls 53 and has a generally rectangular configuration. In one embodiment, housing 52 has a length and a width of about five inches and a height of about six inches, but it

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will be understood that housing 52 may have any desired size depending upon various factors such as the rate at which water is to be heated.

[053] It will be appreciated that housing 52 could have various other numbers of sidewalls 53 and still perform the function thereof. In addition, it will be appreciated that housing 52 could have various other configurations and perform the function thereof. By way of example and not limitation, housing 52 could be square, cylindrical, oval, elliptical, and the like or combinations thereof. For example, Figure 7 illustrates another embodiment of heating assembly 250 where housing 252 has by way of example and not limitation a generally cylindrical configuration.

[054] As illustrated in Figures 1 and 2, in one embodiment heating assembly 50 also includes an inlet 54 that is disposed on one side of housing 52 and it is connected to intake tube 40. Inlet 54 allows the water to flow into a heat transfer conduit 56 (see Figure 4) disposed inside housing 52. As shown in Figures 4-6, in one embodiment heat transfer conduit 56 includes an elongated coiled tube 58 that spirals upwardly within housing 52 towards an outlet 60.

[055] Portable water heater 10 also comprises a heat transfer means for transferring the heat produced by fuel burner 112 to water flowing through heat transfer means. One example of structure capable of performing the function of such a heat transfer means includes heating assembly 50. In one embodiment, heating assembly 50 comprises heat conduit 56 disposed in housing 52. It will be appreciated various other embodiments of structure are capable of performing the function of such a heat transfer means.

[056] In one embodiment shown in Figure 4, tube 58 includes a plurality of closely spaced coils having one or more different diameters D relative to the longitudinal axis

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of heat transfer conduit 56 that decrease in length as tube spirals upwardly. In one embodiment, decrease in diameter D of the coils results in heat transfer conduit 56 having a conical-like shape. More specifically, in one embodiment illustrated in Figures 4-6, coiled tubing 58 of heat transfer conduit 56 is generally disposed about a generally centrally located vertical axis 62 within housing 52. A first coil 64 is located proximate the lower end of housing 52 and is attached to sidewalls 53 of housing 52 by bracket 66. In one embodiment, two brackets 66 are used to attaché first coil 64 to the lower end of housing 52. It will also be appreciated that various other numbers of brackets 66 may be used to carry out the function thereof. Brackets 66 hold tubing 58 of first coil 64 in a generally stationary position, but may allow some amount of movement, such as expanding movement, for example, while the water is heated as it flows through portable water heater 10. It will be appreciated that various types of fastening or connecting methods could be used to generally keep tubing 58 of first coil 64 in place with respect to housing 52.

[057] In one embodiment, first coil 64 has an inside diameter such that the outer portion of coil 64 is disposed proximate, or actually touches, sidewalls 53 of housing 52. In one embodiment depicted in Figures 5 and 6, first coil 64 is part of a first series of coils 68 that spiral generally upwardly. This first set of coils 68 in one possible embodiment has an inside diameter X that is about four inches or smaller.

[058] In one embodiment shown in Figures 5 and 6, coiled tubing 58 of heat transfer conduit 56 also includes a second set of coils 70 that have an inside diameter Y that is smaller than the inside diameter X of the first set of coils 68. In one embodiment, second set of coils 70 has an inside diameter Y of about three inches, but one skilled in the art will appreciate that second set of coils 68 may have any suitable

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diameter depending, for example, upon the size of housing 52, the rate at which water is to be heated or the diameter of the tubing. It will be appreciated that heat transfer conduit 56 could have various other configurations and perform the function thereof. For example, first set 68 and second set 70 of coiled tubing could be each in the shape of two cylindrical portions joined together. Alternatively, first set 68 and second set 70 of coiled tubing 58 could be configured to form a conical shape or two conical shapes that are joined together. In addition, by way of example and not limitation, first set 68 and second set 70 of coiled tubing 58 of heat transfer conduit 56 could be reversed.

[059] Figure 7 depicts another embodiment of heating assembly 250 which includes another possible embodiment of coiled tubing 258. As seen in Figure 7, in this embodiment coiled tubing 258 has a generally conical shape. By way of example and not limitation, coiled tubing 258 has a generally conical shape with a generally decreasing radius. As illustrated, coiled tubing 258 has generally constantly decreasing radius. It will be appreciated that various other configurations of coiled tubing 258 are capable of performing the function thereof. Further, it will be appreciated that coiled tubing 258 may have any suitable radius depending, for example, upon the size of the housing 252, the volume of water to be heated or the diameter of the tubing.

[060] Figure 8 depicts another embodiment of heat transfer conduit 56 for heating assembly 50 of a portable water heater 10. As illustrated, heat transfer conduit 56 includes coiled tubing 58 in a generally cylindrical shape with substantially only one diameter Z. In other words, heat transfer conduit 56 is substantially all the same diameter Z.

[061] In the various configurations for heat transfer conduit 56, coiled tubing 58 is sized and positioned to efficiently heat the water passing there through. In particular,

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heat transfer conduit 56 is configured to effectively and efficiently heat the water as it flows to the shower. For example, the individual coils of the tubing 58 are preferably spaced apart to allow air to flow around the tubes. This space between the coils allows the entire outer surface of the coil to be heated, thereby increasing the efficiency of portable heater 10. However, the coils of tubing 58 are still spaced close enough to each other to allow heat from one coil to be transferred to an adjacent coil to further increase the efficiency of portable water heater 10.

[062] In one embodiment, coiled tubing 58 is spaced apart by a distance of about 0.25 inches to about 0.125 inches. However, it will be appreciated by one skilled in the art that various other suitable distances may be used to separate the coils. One skilled in the art will appreciate that coiled tubing 58 may also be divided into various other numbers of series of coils and that the coils or series of coils may have any suitable diameters. By way of example and not limitation, one skilled in the art will appreciate that coiled tubing 58 might alternatively be divided into three or more series of coils and perform the function thereof.

[063] In addition, one skilled in the art will appreciate that one or more of the adjacent coils of coiled tubing 58 may touch one another and still perform the function thereof. Further, it will be appreciated that coiled tubing 58 may have other suitable arrangements and configurations, such as conical that are appropriate for the intended use of portable water heater 10.

[064] In one embodiment, coiled tubing 58 is constructed from a material, such as copper, that facilitates rapid heat transfer. It will be appreciated by one skilled in the art that various other suitable types of materials including other metals, such as aluminum or stainless steel, may also be used. Additionally, in one embodiment, coiled tubing 58

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extends generally from the lower portion of housing 52 to the upper portion of housing 52 such that the tubing generally fills the heating assembly 50. This configuration advantageously increases the heat transfer achieved by heat transfer conduit 56 by providing a large amount of surface area of coiled tubing 58 while simultaneously minimizing the size of the housing 52.

[065] As shown in Figure 2, a handle 80 is attached to housing 52 of heating assembly 50 to facilitate carrying of portable water heater 10. Handle 80 is in one embodiment pivotally attached to housing 52 and allows heating assembly 50 to be attached to a support if desired. Figures 5 and 6 illustrate in further detail that in one embodiment handle 80 is attached to housing 52 by inserting a first end 82 of handle 80 through a hole in a sidewall 53 of housing 52, and a second end 84 of the handle through a hole in an opposing sidewall 53. In one embodiment of handle 80, first and second ends 82, 84, respectively, of handle 80 have a length sufficient to extend through the holes in sidewalls 53 and between two adjacent coils of the tubing 58. Alternatively, first and second ends 82 and 84, respectively are long enough to extend through the holes in the particular side wall 53 of housing 52 and past the inside diameter of coiled tubing 58. However, in this embodiment, by way of example and not limitation, first end 82 and second end 84 are on opposing ends of handle 80 and are not connected. In this particular embodiment first end 82 and second end 84 of handle 80 are retained therein by conventional movable attachment methods.

[066] Advantageously, in these embodiments first and second ends 82 and 84, respectively, of handle 80 help position and secure coiled tubing 58 within the housing 52. Of course, one skilled in the art will appreciate that handle 80 may be attached to the housing 52 in a variety of ways well known in the art. It will also be appreciated

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that various other configurations of handle 80 are capable of carrying out the function thereof. For example, first and second ends 82 and 84, respectively, are not required to extend past the inner diameter of coiled tubing 58. In fact, in another embodiment, first and second ends 82 and 84, respectively, of handle 80 may only extend just past side wall 53 of housing 52.

[067] Housing 52 also includes an upper inner surface 86, as shown in Figure 6, disposed near the top of housing 52. In one embodiment of portable water heater 10, inner surface 86 includes brackets 88 that help hold coiled tubing 58 in the desired position. As illustrated, in one embodiment, two brackets 88 are used to hold coiled tubing 58 in place. It will be appreciated that various other numbers of brackets 88 could be utilized to hold coiled tubing 58 in place. It will also be appreciated by one skilled in the art that various other fastening or retaining methods could be used in housing 52 to retain coiled tubing 58 in position.

[068] Housing 52 of heating assembly 50 also includes a plurality of apertures 90 disposed in the upper portion of sidewalls 53 to allow the flow of air and gas to exit heating assembly 50 which will be discussed in further detail. Additionally, in one embodiment housing 52 has a generally flat, planar upper surface 92 that advantageously allows items to be placed on upper surface 92 of heating assembly 50. Advantageously, food, small articles of clothing, or other objects may be heated on upper surface 92 of housing 52 while portable water heater 10 is operating. Upper surface 92 also helps to prevent rain and other items from entering heating assembly 50 when the portable water heater is being used outdoors. In alternative embodiment shown in Figure 7, housing 252 has an upper surface 292 is that removably attached to the housing 252.

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[069] It will be appreciated that while apertures 90 are depicted as being round in one embodiment, apertures 90 may have various other shapes and configurations. By way of example and not limitation, apertures 90 may be oval, elliptical, octagonal, square, rectangular, or the like, or any combination thereof. In addition, it is contemplated that upper surface 92 may have apertures 90 formed therein.

[070] Returning to Figure 2, attached to the lower portion of housing 52 of heating assembly 50 is a heat source 100 that includes a fuel source 102. Fuel source 102 is preferably a container or tank of combustible gas, such as propane, but other suitable types of fuel may also be used. In one embodiment, the container for fuel source 102 is a pressurized cylinder of gas that contains about 16.4 ounces of fuel, but it may contain any desirable amount of gas depending upon the intended use of the portable water heater 10. It will be appreciated that various other sizes of containers for fuel source 102 may be utilized. It is contemplated that the size of fuel sources that are readily available can be utilized. In addition, various other sizes of containers may be used. By way of example and not limitation, the container of fuel source 102 may include up to five gallons, or more, of gas for extended use of portable water heater 10 in a remote cabin or at a large campsite with numerous people. Similarly, it is contemplated that the container for fuel source 102 may be of the style often used for campers, barbeques and the like. Alternatively, the container for fuel source 102 may include only a few ounces of gas for use by backpackers, hikers and mountain climbers.

[071] As illustrated in Figure 3, in one embodiment heat source 100 also includes a fuel burner assembly 104, which combusts fuel to create heat in heating assembly 50. Figures 3, depicts one embodiment of fuel burner assembly 104. As illustrated in Figure 3, in one embodiment fuel burner assembly 104 includes a connector 107 which

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connects fuel burner assembly 104 to fuel source 102 (see Figure 1). As illustrated in Figure 3, connector 107 connects fuel source 102 (see Figure 1) to a fuel conduit 108.

[072] Turning now to Figures 5 and 6, in one embodiment fuel conduit 108 has a first end 108A and a second end 108B. Second end 107B of connector 107 is attached to first end 108A of fuel conduit 108. Fuel conduit 108 also includes openings 113 that are spaced about fuel conduit 108 to allow air to be mixed with the fuel to promote efficient burning of the fuel. Accordingly, openings 113 are sized and configured to create the proper air-fuel mixture for efficient combustion of the fuel. In one embodiment, fuel conduit 108 has four openings 113 formed therein. It will be appreciated by one skilled in the art that various other numbers of openings 113 could be utilized to carry out the function thereof. Further, in one embodiment, openings 113 are equally spaced about the circumference of fuel conduit 108. It will be appreciated that various other configurations of openings 113 may be utilized to carry out the intended function thereof.

[073] Burner 112 is attached to the second end 108B of fuel supply tube 108 and includes a plurality of openings to release the fuel-air mixture where the flame will occur. Fuel burner assembly 104 is connected to fuel source 102 (not shown) by a connector 107. As illustrated most clearly in Figure 6, in one embodiment, connector 107 is connected to fuel source 102 (not shown) by threads that allows fuel burner assembly 104 to be releasably connected to fuel source 102. Connector 107 includes a control valve 110 that controls the flow of fuel from fuel source 102 to fuel burner assembly 104. Control valve 110 has a control knob 110A attached thereto and is disposed in connector 107 to selectively control the flow of fuel through connector 107.

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A needle 105 extends from connector 107 into the outlet of fuel source 102 (not shown) to enable fuel from the fuel source to flow into connector 107.

[074] Figure 7 illustrates another embodiment of fuel burner assembly 104. In this embodiment burner 212 is configured to extend vertically along the central axis of coiled tubing 258 disposed in one embodiment of heating assembly 250 and housing 252. One advantage of this embodiment is that because one or more of sections of the coils of coiled tubing 258 decrease in diameter as coiled tubing 258 spirals upwardly, at greater portion of coiled tubing 258 are directly exposed to the heat from burner 212. In other words, where coiled tubing 258 is configured as illustrated in Figure 7, least some if not all of the lower and upper coils of coiled tubing 258 are directly exposed to the heat from the burner 212.

[075] Turning back to Figure 3, a shield 114 is attached to fuel conduit 108. In one embodiment, shield 114 includes two opposing, upwardly extending sidewalls 116, 118. In one embodiment, sidewalls 116 and 118 are extending angularly away from each other in an upward direction. It will be appreciated that sidewalls 116 and 118 could be oriented in different configurations. By way of example and not limitation, shield 114 may have sidewalls 116 and 118 which extend substantially vertically upward. Accordingly, shield 114 could be shaped as an open box-like structure.

[076] In one embodiment of shield 114 depicted in Figures 3 and 6, sidewalls 116, 118 of shield 114 include a plurality of openings 120 to allow air to be introduced into heating assembly 50. It will be appreciated that while openings 120 are in one embodiment depicted as being round, openings 120 may have various other shapes such as being oval, elliptical, square, rectangular, octagonal or the like or combinations thereof. In one embodiment, shield 114 also includes open opposing ends 122, 124 to

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allow additional air to be introduced into heating assembly 50. Advantageously, shield 114 allows a large quantity of air to be introduced into heating assembly 50 while also protecting burner 112 from damage and generally preventing the user or other objects from touching the burner or contacting the burning gas.

[077] In one embodiment, shown in Figure 5, the upper portions of sidewalls 116, 118 of shield 114 are separated by generally the same distance as sidewalls 53 of housing 52 such that heat source 100 can be readily attached to heating assembly 50. As a result, the upper portions of sidewalls 116, 118 are configured to be inserted into corresponding flanges 126, 128 in housing 52 to create a friction engagement of heat source 100 to heating assembly 50. It will be appreciated that various other ways of attaching shield 114 to housing 52 could be utilized.

[078] By way of example and not limitation, sidewalls 116, 118 of shield 114 may be either slightly compressed or expanded to create a more secure connection of heat source 100 to heating assembly 50. As illustrated in Figure 2, in one embodiment, flanges 126, 128 of housing 52 may include one or more inwardly extending bumps or protrusions 129 that engage sidewalls 116, 118 of shield 114 (see Figure 5). Advantageously, this friction and/or compression engagement of heat source 100 and heating assembly 50 creates a secure, but releasable connection that allows portable water heater 10 to be easily assembled and disassembled. Alternatively, in another embodiment heat source 100 and heating assembly 50 are connected by any suitable means well known in the art such as rivets, screws, hinges, welding, glue, and the like.

[079] Advantageously, heating assembly 50 and heat source 100 efficiently heat the water traveling through coiled tubing 58 because burner 112 is located near coiled tubing 58. Further, in one embodiment, because one or more of the coils of tubing 58

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decrease in diameter as coiled tubing 58 spirals upwardly, at least some if not all of the lower and upper coils 58 are directly exposed to the heat from burner 112. Alternatively, where coiled tubing 58 forms a generally cylindrical shaped body, coiled tubing 58 allows the heat from burner 112 to flow upwardly past the coils without being impeded.

[080] Shield 114 also increases the efficiency of portable shower heater 10 by directing the heat from burner 112 toward coiled tubing 58. More specifically, in one embodiment, angled sidewalls 116, 118 of shield 114, which is constructed from metal, assist in directing the heat from burner 112 towards coiled tubing 58, and housing 52, which is constructed from metal, also helps direct the heat from burner 112 to coiled tubing 58. It will be appreciated that various types of materials capable of withstanding heat may be utilized as the coiled tubing 58 and/or housing 52.

[081] In one embodiment, illustrated in Figure 6, upper inner surface 86 of housing 52 helps retain the heat from burner 112 within the housing while allowing the combustion gases to escape through the apertures 90 near the top of sidewalls 53 of housing 52. Thus, heating assembly 50 provides for efficient heating of the water due to the effective heat transfer from the heat source to the water, and the loss of heat from heating assembly 50 is minimized.

[082] Referring to Figure 2, an outlet assembly 130 is attached to the upper portion of heating assembly 50 to allow the water to flow from the coiled tubing 58 into an outlet conduit 132. More specifically, outlet conduit 132 is connected to outlet 60. In one embodiment, outlet conduit 132 is comprised of a resilient, flexible material. It will be appreciated that outlet conduit 132 may have various configurations and perform the function thereof. A fixture 134, such as a showerhead, may be attached to outlet

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conduit 132 depending upon the intended use of water heater 10. It will be appreciated that other suitable types of fixtures 134, or no fixture at all, may be used depending upon the intended use of portable water heater 10.

[083] The portable water heater 10 may also include a carrying case (not shown) that allows the device to be easily transported and assembled. The carrying case desirably allows all the components of portable water heater 10 to be stored when it is not in use. Advantageously, the carrying case can also be used to store and contain water for the water heater 10. That is, the carrying case can be filled with water to serve as water source 11 for portable water heater 10.

[084] In greater detail, the carrying case preferably includes a recessed handle and a removable lid. The removable lid is preferably releasable attached to a body of the carrying case by two or more hinges that allow the lid to be removed. The removable lid includes a recessed portion or cavity that is sized and configured to receive all or a portion of water heater 10. In one embodiment, the recessed portion is sized and configured to receive and hold one or more pressurized gas cylinders in an upright position. Advantageously, the lid provides a sturdy and stable base for portable water heater 10, whether or not the lid is attached to the body of the carrying case. A preferred embodiment of the carrying case is disclosed in co-pending United States provisional patent application serial number 60/312,550, filed on August 15, 2001, (attorney docket number 15474.5), which was converted into a United States patent application serial number 10/222,732, filed on August 15, 2002 (attorney docket number 15474.5.1), which is hereby incorporated by reference in its entirety.

[085] As illustrated in Figures 1-3, in order to assemble portable water heater 10, fuel burner assembly 104 with gas burner 112 is connected to fuel source 102, such as

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a pressurized cylinder 106 filled with propane. In particular, fuel conduit 108 allows fuel burner assembly 104 to be quickly and easily connected to the pressurized cylinder that is the fuel source 102 by simply screwing or twisting fuel burner assembly 104 on to fuel source 102. Heating assembly 50 may then be connected to heat source 100 by a friction and/or compression fit. In one embodiment, housing 52 of heating assembly 50 includes a pair of flanges 126, 128 that allow heat source 100 to be securely fastened to heating assembly 50. Alternatively, heating assembly 50 and heat source 100 may be permanently connected by means such as by riveting or welding. One skilled in the art will appreciate that portable water heater 10 can also be assembled in other desired sequences and orders.

[086] In operation, intake 12 is inserted into or connected to water source 11 such that water is provided to portable water heater 10, and power is supplied to pump 20 by power supply 30. For example, the user can insert intake 12 and pump 20 into a bucket of water as shown in Figure 1, and the user can depress the on/off switch 38 on power supply 30 to turn pump 20 on and draw water from water source 11 through intake 12. The user then turns on heat source 100 by opening gas control valve 110 and igniting the gas either manually or automatically. Thus, water is now flowing through water heater 10 and the water is being heated by heat source 100. One skilled in the art will appreciate that the volume of water being pumped is generally dependent upon the size and speed of the pump. Thus, the speed or size of the pump can be increased to supply a larger volume of water.

[087] In greater detail, the water flows through pump 20, intake tube 40, intake 12, and into heating assembly 50 where the water enters heat transfer conduit 56. As the water traverses heat transfer conduit 56, heat from heat source 100 heats the water. In

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particular, coiled tubing 58 absorbs the heat from heat source 100, and transfers the heat to the water as it flows through coiled tubing 58. In one embodiment coiled tubing 58 spirals upwardly and has a decreasing diameter, such that the coils assume a conical shape, exposing at least some of the upper coils directly to the heat from heat source 100. Advantageously, this configuration increases the transfer of heat from heat source 100 to the water because more of the coils are heated to a higher temperature. Additionally, as discussed above, coiled tubing 58 is spaced apart to facilitate heating of coiled tubing 58 and to allowing hot air and gases to flow around coiled tubing 58. This arrangement further increases the heat transfer between the heat source 100 and coiled tubing 58. Advantageously, because heat transfer conduit 56 has a large surface area, is located proximate to heat source 100, and is constructed from materials that facilitate the transfer of heat, the water is quickly and efficiently heated. In one embodiment, coils are formed in a generally cylindrical shape. In this embodiment heating of the water is obtained efficiently because of the large surface area, proximity to heat source 100 and is constructed from materials made to efficiently transfer heat.

[088] The heated water then exits heating assembly 50 through outlet 60 and enters outlet assembly 130. More specifically, water enters outlet conduit 132. Outlet conduit 132 is connected to any suitable fixture 134, such as a showerhead, which can be used for any desirable task or undertaking such as taking a shower.

[089] Once hot water from water heater 10 is no longer needed, the user simply extinguishes heat source 100 by turning control valve 110 into the off position and turning pump 20 off. Extinguishing heat source 100 stops the heating of the water, and turning off pump 20 stops the flow of water through water heater 10. The user can then detach intake tube from either pump 20 or inlet 54 and allow the water to drain from

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portable water heater 10. Portable water heater 10 is now ready to be disassembled, moved or transported. Advantageously, portable water heater 10 can also be quickly disassembled for storage or transport. For example, heating assembly 50 can be disconnected from heat source 100, and fuel burner assembly 104 can be disconnected from fuel source 102. This disconnected state allows the various components to be stored in a relatively small area, such as inside the carrying case.

[090] Turning now to Figures 9 through 16, another embodiment of a portable water heater 300 is illustrated containing features of the present invention. Water heater 300 includes many of the features and functions as the other portable water heaters disclosed herein. Water heater 300 provides one possible alternative configuration for the components thereof. In one embodiment, water heater 300 can be used in more commercial or industrial settings where a larger volume of water is required. Water heater 300 is also useful where larger quantities of water are needed, such as in, but not limited to, military, emergency, disaster or hazardous waste clean-up, fire, hospital, decontamination, and other similar settings. However, water heater 300 may also be used in more personal settings as described above.

[091] As shown in Figures 10, 11 and 13, heating assembly 302 has an outer housing 303. In one possible embodiment, outer housing 303 is formed by a front wall 304a, rear wall 304b, sidewalls 306a and 306b, top cover 308a and bottom cover 308b. As shown in Figures 12 and 14, respectively, walls 304a, 304b, 306a, 306b form a top opening 305a (Figure 12) and a bottom opening 305b (Figure 14) . A top cover 308a (illustrated in Figure 10) is configured to be disposed over the top opening 305a and a bottom cover 308b (shown in Figure 11) can be disposed over the bottom opening 305b.

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[092] As illustrated in Figure 15, heating assembly 302 includes a heat transfer conduit 316 and burner assembly 340 discussed in more detail below. As discussed above, the water heaters of the present invention can be used for many personal applications such as providing hot showers. For larger, more industrial applications, the size of the water heater may be increased to accommodate a larger volume of water.

[093] Returning to Figure 13, in one embodiment, portions of outer housing 303 can further be constructed in sections forming a front portion 310a and a rear portion 310b. Front portion 310a is substantially U-shaped structure, the base of the U-shaped structure forming the front wall 304a and the legs 311a of the U-shaped structure forming a portion of sidewalls 306a, 306b. Rear portion 310b is correspondingly substantially U-shaped in construction. The base of the U-shaped structure of portion 310b forms rear wall 304b and the legs 311b form a portion of sidewalls 306a, 306b. In addition, in one embodiment, the legs 311b of rear portion 310b include inwardly bent first lip 312a and second lip 312b at the ends thereof. It will be appreciated that various other configurations could be used to form outer housing 303 such as pieces joined the corners to form walls 304a, 304b, 306a, 306b. In another embodiment, walls 304a, 304b, 306a, 306b could be integrally formed.

[094] Returning to Figure 10, front wall 304a may include a plurality of holes 338 to allow portions of components of the burner assembly and/or heat transfer conduit to be accessible outside outer housing 303, which will be discussed in more detail below. Outer housing 303 may include other features not shown in the embodiment of Figures 9 and 10, including, but not limited to, a handle, apertures in outer housing 303 for releasing heat, apertures for connecting portions of outer housing 303 together, and the

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like. Furthermore, it will be appreciated that outer housing 303 may have various other configurations for performing the functions described herein.

[095] As shown in Figure 9, in one application, heating assembly 302 is mounted on a portable platform such as a dolly 301. It will be appreciated that heating assembly 302 can also be mounted to various other mobile structures, such as, but not limited to, a cart, other wheeled structures, skis, sleds, tracks, and the like.

[096] With reference to Figures 12 and 13, a heat transfer conduit 316 is disposed within outer housing 303. An intake conduit 318 and an outlet conduit 320 can enter outer housing 303 to be placed in fluid communication with opposing ends of heat transfer conduit 316. Although not shown, intake conduit 318 can be connected to a pump or other fluid source. Similarly, outlet conduit 320 can terminate in an appropriate spray head as described above.

[097] Appropriate inlets and/or outlets may be formed in outer housing 303 as required to allow intake conduit 318 and/or outlet conduit to 320 to enter outer housing 303. For example, as shown in Figure 11, an aperture is formed in bottom cover 308b to allow intake conduit 318, outlet conduit 320 and a fuel conduit 324 (which will be described further below) to enter outer housing 303. However, intake conduit 318, outlet conduit 320 and/or fuel conduit 324 may be positioned at any suitable location of outer housing 303 depending on design configurations. Further, while the embodiment depicted in Figure 11 shows intake conduit 318, outlet conduit 320 and fuel conduit 324 positioned together, it will be appreciated that the intake conduit, outlet conduit, and/or fuel conduit may be positioned together or be spaced apart without effecting the functions thereof.

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[098] As shown in Figure 12 and 13, in one embodiment, heat transfer conduit 316 is constructed of a coiled tube 326. That is, the coiled tube 326 includes a tubular conduit which is wrapped in a coil configuration. In one embodiment, the cross-section of the tubular conduit can be substantially circular. It will be appreciated that the cross-section of the tubular conduit may take on various configurations including, but not limited to, oval, round, square, parabolic, polygonal, and the like.

[099] One end of intake conduit 318 is connected to a first end of coiled tube 326 and an end of outlet conduit 320 is connected to the second end of coiled tube 326. In one embodiment, coiled tube 326 has a substantially cylindrical cross-section. The cross-section of the coiled tube 326 can, but is not required to, have a constant diameter. For example, the cross-section of the coiled tube 326 can have a smaller diameter at one end than at the other, or the cross-section of the coiled tube could have a smaller diameter in the middle portion thereof than at the opposing ends thereof. It will be appreciated that, as discussed above, the cross-section of coiled tube 326 may have various configurations such as, but not limited to, oval, round, square, rectangular, or any combination thereof.

[0100] In the embodiment shown in Figures 12 and 13, coiled tube 326 can be disposed along a horizontal axis 327 instead of a vertical one as shown in previous embodiments. Yet, it is possible for the coiled tube 326 to be placed along a vertical axis. Further, heat transfer conduit 316 may vary in length or shape. In another embodiment, more than one heat transfer conduit 316 may be disposed in the outer housing 303. For example, a smaller coiled tube can be placed within a larger coiled tube, as discussed above.

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[0101] As most clearly shown in Figure 13, in another embodiment, heat transfer conduit 316 is positioned in and mounted in a chamber 328 formed in outer housing 303. Chamber 328 is at least partially formed by two side plates 330a, 330b, a front plate 330c, and a rear plate 330d. The chamber 328 provides locations to connect portions of heat transfer conduit 316 (Figure 13) and/or burner assembly 340 (Figure 15). Side plates 330a and 330b support heat transfer conduit 316 as described below. Plates 330 can also provide added structural support to outer housing 303.

[0102] In one embodiment, although not shown, heat transfer conduit 316 can extend substantially across the length of outer housing 303 and be mounted to outer housing 303, such as with welds, adhesives, friction fits, combinations thereof, or other manner for securely mounting the heat transfer conduit. The heat transfer conduit 316 absorbs heat emitted by burner assembly 340 (discussed further below) during combustion of the fuel and transferring the heat to fluid flowing through the heat transfer conduit 316. In one embodiment, the heat transfer conduit 316 is composed of copper, metals, or other conductive material. It will be appreciated that heat transfer conduit 316 could be composed of other materials that are capable of transferring heat.

[0103] Plates 330 also assist to return the heat near heat transfer conduit 316 and can also serve to partially insulate the walls of outer housing 303. By retaining the heat generated by the fuel burner assembly 340 toward heat transfer conduit 316, and insulating at least a portion of the heat produced by the fuel burner assembly from reaching the front wall 304a, rear wall 304b, and side walls 306a, 306b. Plates 330 help reduce the amount of heat that reaches outer housing 303 so as to keep the surface of outer housing 303 cooler during operating of water heater 300. Plates 330 thereby increase the safety of the water heater 300 by reflecting the heat produced by the fuel

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burner assembly away from outer housing 303 so that outer housing 303 is not the primary point of heat contact. Plates 300 can be constructed of the same or different material as outer housing.

[0104] As shown in Figure 13, side plates 330a and 330b can be connected to side walls 306a, 306b by, for example, outwardly curved portions formed at the ends of the side plates. In one embodiment, front plate 330c is disposed across the opening formed by the legs of rear portion 310a. The ends of front plate 330c are connected to optional lips 312a, 312b of rear portion 310a. It will be appreciated that front plate 330 could be attached to outer housing 303 in various other locations and manners. In the embodiment illustrated, rear plate 330d includes an upwardly bent rim. Opposing ends of the rim are connected to side plates 330a, 330b. It will be appreciated by one skilled in the art that various other configurations of rear plate 330d could be used. Further, rear plate 330d could be attached to side plates 330a, 330b in various other manners known in the art. Finally, when top cover 308a and bottom cover 308b are placed over top opening 305a and bottom opening 305b, respectively, chamber 328 is formed. Connection between the various components of chamber 328 can be made by welding, bolting, riveting, and the like.

[0105] As shown in Figure 12, in one embodiment, the top region of front plate 330c extends past the edges of side walls 306a, 306b. During operation, the top cover 308a is placed over the top opening 305a as depicted in Figure 10. Returning to Figure 12, the top cover 308a includes a lip around the edge thereof, which can be configured to be disposed inside or outside of the top opening 305a. The lip of top cover 308a includes slots 358 positioned to receive portions of outer housing and/or plates 330. Thus, when the top cover 308a is disposed over the top opening 305a, slots 358 receive a portion of

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the top edge of front plate 330c, thus substantially sealing the top opening 305a. Because the top edge of front plate 330c extends past sidewall 306a, 306b, it abuts the surface of top cover 308a so that chamber 328 is substantially sealed from the rest of outer housing 303, at least in the top region. In addition, the surface of top cover 308a includes a plurality of apertures 360, which are in communication with chamber 328. It will be appreciated that top cover 308a may have various configurations so long as it performs the function of covering the top opening 305a and cooperates with outer housing 303. In addition, top cover 308a is not absolutely necessary for the adequate operation of water heater 300.

[0106] In one embodiment illustrated in Figure 14, the bottom region of rear plate 330d includes optional channels 356 so that portions of burners (discussed below) of burner assembly 340 can extend therethrough and be connected to rear wall 304b of outer housing 303. Brackets 348 are provided for securely connecting the burners to rear wall 304b. Also shown in Figure 14, bottom region of side plates 330a, 330b include notches 364 formed therein. When bottom cover 308b is placed over the bottom opening 305b, the notches 364 allow heat from chamber 328 to escape therethrough.

[0107] As shown in Figure 11, the bottom cover 308b covers the bottom opening 305b. The bottom cover 308b includes a lip around the edge thereof, which can be configured to be disposed inside the bottom opening 305b or outside the bottom opening 305b. The surface of the bottom cover 308b includes a plurality of apertures 362 so that heat from chamber 328 can be released therefrom. It will be appreciated, however, that since the burners (discussed below) are facing away from the bottom opening 305b, less heat will be released from bottom cover 308b than from top cover

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308a. It will also be appreciated that bottom cover 308b may have various configurations so long as it performs the function of covering bottom opening 305b. In addition, it will be appreciated that bottom cover 308b is not absolutely necessary for the suitable operation of water heater 300. Thus, as used herein, the term "housing" does not require that the walls of the housing form a complete enclosure.

[0108] As shown in Figure 13, one or more support rods 336 extend between side plates 330a, 330b. The support rods 336 can be connected to side plates 330a, 330b through welding, riveting, bolting, and the like. It will also be appreciated that, alternatively, support rods 336 could be mounted to side walls 306a and 306b without affecting the function thereof. The coiled tube 326 of heat transfer conduit 316 is disposed about support rods 336 so that the weight of the coiled tube can be evenly distributed thereon.

[0109] Turning now to Figures 14 and 15, burner assembly 340 is disposed proximate to heat transfer conduit 316. As shown in Figure 16, components of the burner assembly 340 are thus positioned below heat transfer conduit 316. As mentioned above and as will be described in more detail below, outer housing and plates 330 can provide structural support for portions of the fuel burner assembly 340. As depicted in Figures 14 and 15, fuel burner assembly 340 includes two or more burners 346 that are mounted in closed proximity to and generally disposed from heat transfer conduit 316.

[0110] The burners 346 can be 35,000 BTU burners and fabricated from cast-iron or other material capable of withstanding the elevated temperatures. Although reference is made to 35,000 BTU burners, one skilled in the art will understand that burners 346 can be rated greater or lesser then 35,000 BTU. Additionally, although only two burners are shown, one can understand that water heater 300 can include a greater or lesser number

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of burners. Furthermore, while two burners 346 are shown in the embodiment of Figures 14 and 15, it will be appreciated that a user can control the burners so that one burner operates while the other is unoperational. In addition, the user can vary the amount of fuel that is directed to each burner 346 so that one burner may be operating at a higher temperature than the other.

[0111] With further reference to Figure 15, to supply burners 346 with fuel from the fuel source (Figure 9), fuel burner assembly 340 includes fuel conduit 324, one or more connectors 350, and one or more control valve assemblies 344. Fuel conduit 324 attaches to connectors 350 at one end and a conventional propane tank connector at the other end so that fuel burner assembly 340 cooperates with the fuel source, such as a conventional pressurized propane tank (Figure 9). The connectors 350 can include any type of member that directs the flow of fuel from the fuel source, including but not limited to, tubular members, conduit, brackets, metal connectors, or the like. Valve assemblies 344 control the flow of fuel from the fuel source and controls the flow of fuel to burners 346. These valve assemblies 344 can include control knobs 344a, 344b attached thereto to enable a user to open and close valve assemblies 344.

[0112] Cooperating with burners 346 is an ignition device 342. In the exemplary configuration, ignition device 342 is an electric or piezo-electric spark igniter or automatic lighting devices. By manipulating ignition device 342, fuel flowing through fuel conduit 324, connectors 350, and valve assemblies 344 ignites to produce the desire heating of heat transfer conduit 316. It will be understood, that a user can manually ignite fuel exiting from burners 346.

[0113] As shown in Figure 14, front plate 330c includes an inlet for allowing the intake conduit 318 to be connected to the heat transfer conduit 316. Similarly, front

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plate 330c has an outlet for providing a connection between the outlet conduit 320 and the heat transfer conduit 316. The bottom region of front plate 330c includes channels 354 so that a portion of burners 346 can be disposed outside chamber 328. It will be appreciated that various other configurations of openings can be formed in front plate 330 while still allowing the front plate to perform the functions thereof. Brackets 355 are provided for securely connecting the front of burners 346 to front plate 330c. In addition, apertures (not shown) are provided in front plate 330c for allowing portions of the ignition devices 342 to enter chamber 328. For example, a spark igniter connected to the ignition device 342 may be disposed in chamber 328 directly in front of burners 346 to provide a spark so that fuel from the burners can be ignited.

[0114] Returning to Figure 10, a number of holes 338 in front wall 304a provide access to a user to portions of the valve assemblies 344 and ignition devices 342. For instance, one hole 338a can provide access to ignition device 342 (Figure 15) of fuel burner assembly 340 so that a user can ignite the burners. Another hole 338b can receive valve assembly 344 (Figure 15) of fuel burner assembly 340 so that a user can operate the valve assembly to allow fuel to flow from a fuel source (not shown). Further, another hole 338c can receive a temperature control valve assembly 352 (Figure 13) so that a user can control the temperature of the heated water.

[0115] As shown more clearly in Figure 13, the temperature control assembly 352 is disposed in communication with intake conduit 318. The temperature control assembly 352 allows a user to control the volumetric flow of fluid between the intake conduit 318 and the heat transfer conduit 316 so that more or less water flows through. As the flow of water is increased or decreased, the temperature of the water be corresponding decrease or increase. When the flow of water is increased, the water will have less

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residence time in the heat transfer conduit, thus cooling the water. Similarly, a decrease in the flow of water will result in the water having more time to heat in the heat transfer conduit, thus providing hotter water. As shown in Figure 13, the temperature control assembly 352 may also serve the purpose of supporting the intake conduit 318 to outer housing 303. That is, a bracket 322 may be provided to hold a portion of intake conduit 318 against front wall 304a of outer housing 303 so that it is in proximity with the temperature control assembly 352.

[0116] The operation of water heater 300 is similar to that of water heater 10 described with respect to Figures 1-8. A fuel burner assembly is connected to a fuel source by way of various connectors. The valves of the fuel burner assembly prevent flow of fuel to the burners until they are opened through moving one or more control knows. Before moving the valves, the intake conduit and the outlet conduit are mounted to respective inlets and outlets of the heat transfer conduit. The free ends of the intake and outlet conduits are positioned in the desired positions, i.e., the free end of the intake conduit is placed in communication with a pump assembly or water reservoir and the free end of the outlet conduit is placed to provide a spray of water to a desired object (e.g., a human).

[0117] The fuel burners are ignited preferably when water is contained inside the heat transfer conduit to avoid steam formation. The user can open the valve assemblies and ignite the burner by turning the control knobs and manipulating the peizo-electric spark igniters of the ignition device. Lighting the fuel begins a sustained combustion at the surface of the burners and creates a large quantity of heat that is transmitted via radiation and convection in a generally upward direction. The heat is concentrated by the plates of the chamber toward the heat transfer conduit, which is arranged in one

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embodiment to maximize heat transfer from the combustion to the fluid contained therein. The heated water continuously flows through the heat transfer conduit, thereby providing a continuous stream of warm water.

[0118] After transmitting a significant portion of its heat to the heat transfer conduit, the remaining heat and exhaust gases produced by the burners continue to rise past the heat transfer conduit to the top of outer housing 303. This remaining heat and exhaust gases heat the top of outer housing 303, then safely exit into the atmosphere via openings formed therein. The heated top may be used as a heating surface for such things as food or water placed in a container (not shown) or for drying wet articles. The portable water heater can be used in adverse weather without the rain or snow penetrating the burner because of the configuration of outer housing 303.

[0119] As with the other water heaters described herein, generally, the heated water produced by the water heater can be directed to a structure, a vehicle, a human or animal body, or other location where heated water is desired.

[0120] Although the present invention has been described in terms of certain preferred embodiments, other embodiments apparent to those skilled in the art are also within the scope of the invention. Thus, the described preferred embodiments are to be considered in all respects only as illustrative and not restrictive. Accordingly, the scope of the invention is intended to be defined only by the following claims. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

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